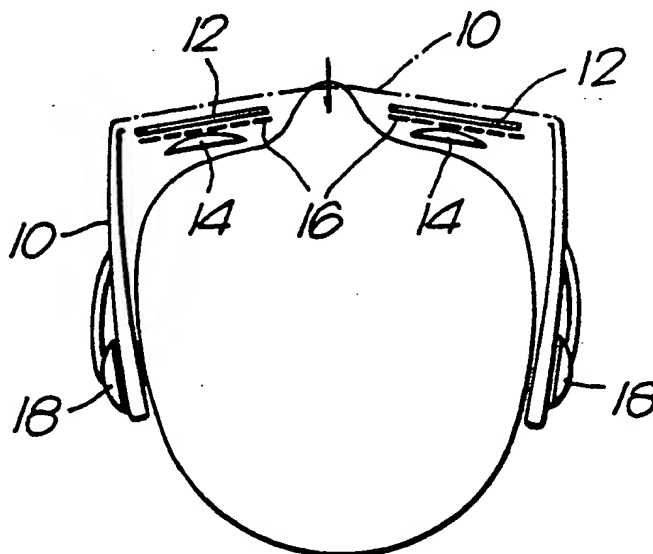




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>5</sup> :</b>  <b>H04N 9/64, 15/00, 13/00</b>	<b>A2</b>	<b>(11) International Publication Number:</b> <b>WO 92/16075</b>  <b>(43) International Publication Date:</b> 17 September 1992 (17.09.92)
<b>(21) International Application Number:</b> PCT/GB92/00396 <b>(22) International Filing Date:</b> 6 March 1992 (06.03.92)  <b>(30) Priority data:</b> 9104960.1                      8 March 1991 (08.03.91)                      GB 9106132.5                      22 March 1991 (22.03.91)                      GB  <b>(71) Applicant (for all designated States except US):</b> DURAND LIMITED [-/GB]; P.O. Box 186, 1 Le Marchant Street, St. Peter Port, Guernsey (GB).  <b>(71)(72) Applicant and Inventor:</b> JOHNSON, William, Nevil, Heaton [GB/GB]; 41 Courtenay Place, Lymington, Hampshire SO4 9NQ (GB).		<b>(74) Agent:</b> HOWDEN, Christopher, A.; Forrester Ketley & Co., Forrester House, 52 Bounds Green Road, London N11 2EY (GB).  <b>(81) Designated States:</b> AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CI (OAPI patent), CM (OAPI patent), DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), GN (OAPI patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC (European patent), MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, PL, RO, RU, SD, SE, SE (European patent), SN (OAPI patent), TD (OAPI patent), TG (OAPI patent), US.  <b>Published</b> <i>Without international search report and to be republished upon receipt of that report.</i>

(54) Title: VIEWING DEVICE



## (57) Abstract

A viewing device for receiving video signals and generating corresponding images for viewing comprises a frame or support (10), adapted to be worn on the user's head, for example a frame similar to a spectacle frame. The frame supports in front of each of the wearer's eyes, a pixelated LCD screen (12) and respective optical systems (14) located between the user's eyes and the screens (12) to allow the user to view the images generated as if they were at infinity. A light-transmitting microlens screen (16) may be located in front of each LCD screen to produce an improved subjective viewing impression by "de-pixelating" the image.

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Title: "Viewing device"

THIS INVENTION relates to a viewing device for presenting to a user visual images, such as televised images or recorded video images.

Conventionally, televised images are viewed on screens which, for practical and technical reasons, occupy a relatively small portion of the visual field of the viewer, so that the visual effect is generally inferior even to that enjoyed by a person viewing a film in a cinema, although even in this case the image viewed may occupy only a minor part of the viewer's visual field. The above-noted drawback is, if anything, greater in the case of the so-called "pocket" television receivers now available and where, by virtue of the extreme miniaturisation of the viewing screen, the proportion of the user's field of view which can be occupied by the picture area is limited by the minimum viewing distance which the user's eyes can comfortably accommodate.

It is among the objects of the present invention to provide an improved viewing device which is portable and yet can provide a picture or display occupying a major part of the user's visual field.

According to the invention, there is provided a viewing device comprising a frame or support adapted to be worn on the user's head, and supporting, so as to be in front of the user's eyes, imaging display means for presenting or reproducing a visual image, and an associated optical system whereby there may be presented to the user's view an image presented or reproduced by said display means, at a comfortable subjective viewing distance.

Preferably said imaging display means comprises a television or video display driven by appropriate circuitry carried by said frame or incorporated in a unit separate from said frame but connected therewith by signal conducting means.

An embodiment of the invention is described below by way of example, with reference to the accompanying drawings, in which:-

FIGURE 1 is a perspective view illustrating a device embodying the invention being worn by a user, and

FIGURE 2 is a schematic plan view, corresponding to Figure 1.

Referring to the drawings, a viewing device embodying the invention comprises a frame 10 which may as illustrated take the general form of a pair of spectacles or goggles. As shown in Figure 2, the frame 10 supports, in front of each eye of the wearer, a respective display screen 12 (viewed upper edge-on in Figure 2) and a respective converging lens or lens system (represented schematically, as a single lens, at 14) through which the respective eye of the user can view, at infinity, a virtual image of the picture area or display area of the respective screen 12. In order to allow the device to be used by a person who is short-sighted and is not using corrective optics independent of the viewing device, the power of the lenses 14 may be adjustable so as to present such virtual image at the appropriate furthest limit of clear vision of the respective eye of the user. It will be appreciated that, in the interests of compactness, the screen 12, lens 14 and the user's eye should all be as close together as possible, which also allows the size, and thus the weight

of each screen 12 and lens or lens system 14 to be minimised.

Each display screen is preferably an LCD screen of the general type used in known hand-held or "pocket" television receivers, and is thus divided into an array or grid of pixels capable of being activated selectively by associated conductors connected with control circuitry, not shown, and which control circuitry, in the preferred embodiment, as in such known hand-held or "pocket" television receivers, is in turn controlled by television-signal receiving and processing circuitry or by other video-signal-processing circuitry, whereby each pixelated screen 12, in operation of the device, will display a televised picture transmitted on a television channel to which said receiving circuitry is tuned or will display a picture corresponding with such other video signal.

Each screen 12 is back-lit, for example by ambient light passing through the screen 12 from the outer side thereof (i.e. the side furthest from the user's eye), either directly or through a diffusing screen (not shown) located on the outer side of the screen 12, or by a diffuse light source, such as a fluorescent panel, located adjacent the screen 12 on the outer side thereof. The two screens 12 may be energised in parallel by the associated circuitry so that the two screens display precisely the same picture. However, it will be appreciated that the two screens 12 may be energised by respective circuitry to display, during each "frame" period of a T.V. transmission or video recording, respective images of a stereoscopic image pair, so that the wearer will see a three-dimensional or stereoscopic picture. Such a stereoscopic or three-dimensional effect will, of course, only be provided if appropriate stereoscopic picture information is available,

i.e. if there is a transmitted stereoscopic television signal, or corresponding stereoscopic picture information, for example derived from a recorder connected with the device.

In order to avoid disturbing effects, on the user's vision, of exposure of the eyes for long periods to entirely pixelated fields of view, and in order to afford a more acceptable viewing impression to the user, a light-transmitting randomising or diffusion screen 16 may be disposed in front of each LCD screen 12, i.e. between the screen 12 and the respective optical system 14. Each such screen 16 preferably takes the form of a microlens screen as hereinafter defined.

The term "microlens screen" is used herein to denote a rear projection screen comprising a sheet of light-transmitting material in or on which is formed, by appropriately configuring one or both surfaces of the sheet, or by causing predetermined localised variations in the refractive index of the sheet material, an array of minute lenses, herein termed "microlenses". Where the lenses are formed by configuring one or both surfaces of the sheet, the microlenses are effectively conventional lenses, for example, plano-convex or bi-convex lenses. Where the lenses are formed by localised variations in the refractive index of the sheet material, the lenses are of the graded refractive index (GRIN) type. The microlens screen may, of course, incorporate both surface configuration and graded refractive index variations contributing to the effectiveness of the microlenses.

Microlens screens falling within the definition set out above are disclosed in Published European Patent Application No. 0294122 to which reference should be had.

In view of the preferred small size of the display screens 12 and the use of the effectively magnifying optical systems 14, the individual microlenses of each screen 16 should be as small as possible and should be packed as closely as possible. By way of example, the diameter of each microlens may be between 5 and 2 microns, with the pitch between adjoining microlenses in each screen being of comparable magnitude. Even smaller microlens sizes and pitches may be utilised, for example down to 1 micron.

Using techniques likewise well known, in the field of hand-held or "pocket" television receivers, the screens 12 are preferably capable of displaying pictures in colour where the device is supplied with a colour T.V. or video signal.

The interposition of the microlens screen 16 between the LCD display and the viewing optics 14 has the effect of removing the otherwise visually obtrusive detail of the pixelation of the LCD display and which detail forms no part of the intended picture content of the image viewed. It will be appreciated that where a colour LCD display is utilised, the colour of any particular element of the picture is represented by the combined illuminations of a respective set of three colour pixels, each providing a respective one of three primary colour components, so that an enlarged, detailed view of the screen 12, in operation, provides substantial and confusing pixelation detail which is not readily perceptible as picture-related.

The microlens screen 16 acts, in a sense, as a spatial Fourier filter removing the high (spatial) frequency image detail which is due to the pixelation

leaving only the lower (spatial) frequencies corresponding to actual picture content. In particular the individual colour pixels are no longer discernible as such but respective areas of the microlens screen viewed are perceived as areas of the intended colour merging with adjoining areas without abrupt changes from pixel to pixel.

The resulting picture is subjectively more acceptable to the eye than the "naked" pixelated display.

The use of a microlens screen as opposed to an ordinary diffusion screen for this purpose, makes it possible to achieve the desired Fourier filtering effect without unacceptable loss of brightness or picture detail, "vignetting", "hot spots" or other defects associated with conventional diffusers.

The frame 10 also carries, as indicated schematically at 18, earphones which, when the device is worn, extend over the ears of the user to provide the user with the sound component of the transmitted television or video programme. Such an arrangement, of course, permits relatively high-fidelity sound to be provided to the user at modest cost and furthermore allows the user to obtain the full effect of stereophonic sound transmissions where these are present.

The television-signal receiving and processing circuitry or video and sound-signal processing circuitry may be carried in its entirety by the frame 10, or, if preferred, only the final stage of the circuitry, driving the displays 12, may be carried by the frame 10 and the remainder of the circuitry carried in a separate casing adapted to be carried in a pocket or on a belt, such remainder of the circuitry being connected with that



carried by frame 10 by a flexible lead as indicated at 20 in Figure 1. Thus, for example, the lead 20 may carry an electrical plug at its end remote from the frame 10 for insertion in a socket in such casing. The last-noted configuration allows substantial adaptability whilst allowing the weight of the frame 10 and components carried thereby to be minimised.

The separate casing referred to may, for example, house a compact video tape player or video compact disc and/or television-signal receiving and processing circuitry.

A domestic television receiver may, in addition to or in place of the conventional picture screen, be provided with a socket to receive such a plug, or with a plurality of such sockets to receive respective said plugs from frames worn by a number of individuals so that each individual will have an ideal view of the transmitted or recorded programme material.

The use of the device of the invention substantially solves the problems arising in presenting stereoscopic television picture information to the viewer, in that whilst an individual viewing device or "spectacles" is required (in common with most previously suggested systems for stereoscopic television), the use of such an individual viewing device, is made to afford, in accordance with the invention, other advantages not otherwise readily obtainable, for example in allowing viewing in colour and in avoiding the need for complex screen structures and signal processing techniques, and in obtaining monoscopic/stereoscopic compatability. Whilst the device has been described in terms of the display of televised or pre-recorded video material, it will be appreciated that

the device may, for example, be controlled by a microprocessor-based game device or computer, or by any other source of video signals.

With a view to improving uniformity of back-lighting of the screens 12, further diffusion screens of the microlens array type may be placed behind the screens 12, i.e. on the opposite sides of screens 12 from the user's eyes.

Even where the picture information supplied is not stereoscopic, the fact that the viewed picture occupies a major part, at least, of the user's field of view provides the user with the impression of being part of the scene viewed rather than merely a viewer of a relatively small picture of such a scene. This effect is, of course, even more pronounced where the scene viewed is presented stereoscopically.

Whilst the preferred form of the viewing device, as described above, utilises back-lit light-transmitting display screens 12, it will be appreciated that, instead, forward projection, reflective display screens may be utilised onto which real images of the respective video pictures are projected by respective optical systems located to one side of the respective eye of the user, for example mounted on the respective leg of the frame 10. If desired, a respective microlens or other diffusion screen may likewise be utilised in conjunction with such front projection screens.

It will be appreciated that the display screens 12 may be of the high-definition, active matrix type, e.g. of the thin film transistor (TFT) type and that any other present or future improvements to lightweight image screens

may likewise be incorporated in a viewing device embodying the invention.

## CLAIMS

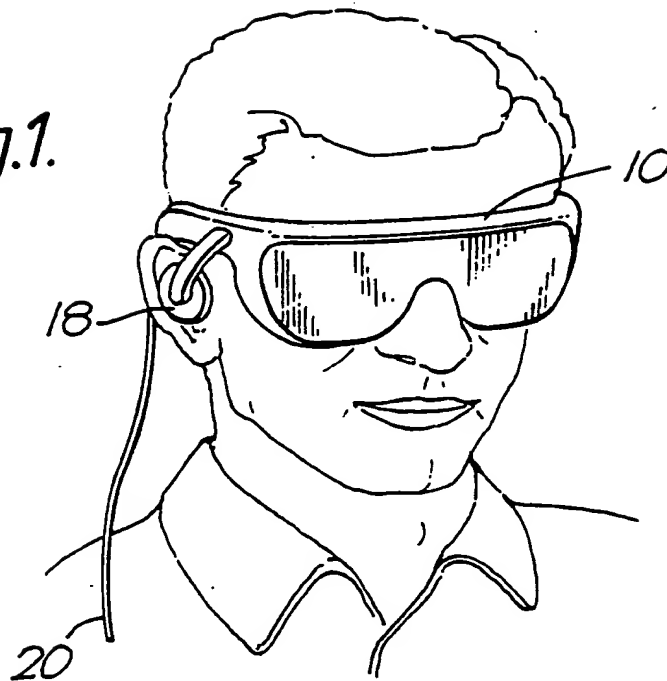
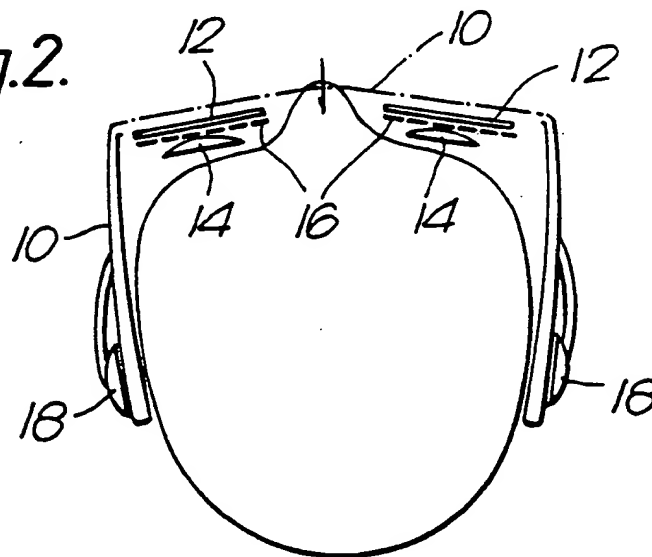
1. A viewing device comprising a frame or support adapted to be worn on the user's head, and supporting, so as to be in front of the user's eyes, imaging display means for presenting or reproducing a visual image, and an associated optical system whereby there may be presented to the user's view an image presented or reproduced by said display means, at a comfortable subjective viewing distance.
2. A viewing device according to claim 1 wherein said imaging display means comprising a television or video display driven by appropriate circuitry carried by said frame or incorporated in a unit separate from said frame but connected therewith by signal conducting means.
3. A viewing device according to claim 1 or claim 2 wherein said imaging display means comprises an LCD pixelated screen.
4. A viewing device according to any preceding claim wherein said imaging display means comprises a respective display screen and a respective associated optical system for each eye.
5. A viewing device according to claim 4 including a respective diffusing or randomising screen interposed between the respective display screen and the respective optical system.
6. A viewing device according to claim 5 wherein the or each said diffusing or randomising screen comprises a microlens screen as herein defined.

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7. A viewing device substantially as hereinbefore described with reference to, and as shown in, the accompanying drawing.

8. Any novel feature or combination of features described herein.

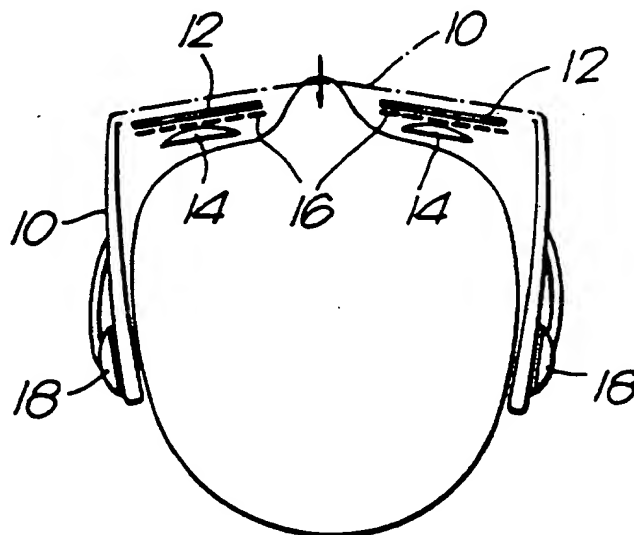
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*Fig.1.**Fig.2.*



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>5</sup> :</b> <b>H04N 5/64, 15/00, 13/00</b>	<b>A3</b>	<b>(11) International Publication Number:</b> <b>WO 92/16075</b> <b>(43) International Publication Date:</b> 17 September 1992 (17.09.92)
<b>(21) International Application Number:</b> PCT/GB92/00396 <b>(22) International Filing Date:</b> 6 March 1992 (06.03.92)  <b>(30) Priority data:</b> 9104960.1                      8 March 1991 (08.03.91)                      GB 9106132.5                      22 March 1991 (22.03.91)                      GB  <b>(71) Applicant (for all designated States except US):</b> DURAND LIMITED [-/GB]; P.O. Box 186, 1 Le Marchant Street, St. Peter Port, Guernsey (GB).  <b>(71)(72) Applicant and Inventor:</b> JOHNSON, William, Nevil, Heaton [GB/GB]; 41 Courtenay Place, Lymington, Hampshire SO4 9NQ (GB).		<b>(74) Agent:</b> HOWDEN, Christopher, A.; Forrester Ketley & Co., Forrester House, 52 Bounds Green Road, London N11 2EY (GB).  <b>(81) Designated States:</b> AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CI (OAPI patent), CM (OAPI patent), DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), GN (OAPI patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC (European patent), MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, PL, RO, RU, SD, SE, SE (European patent), SN (OAPI patent), TD (OAPI patent), TG (OAPI patent), US.  <b>Published</b> <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>  <b>(88) Date of publication of the international search report:</b> 29 October 1992 (29.10.92)

**(54) Title:** VIEWING DEVICE**(57) Abstract**

A viewing device for receiving video signals and generating corresponding images for viewing comprises a frame or support (10), adapted to be worn on the user's head, for example a frame similar to a spectacle frame. The frame supports in front of each of the wearer's eyes, a pixelated LCD screen (12) and respective optical systems (14) located between the user's eyes and the screens (12) to allow the user to view the images generated as if they were at infinity. A light-transmitting microlens screen (16) may be located in front of each LCD screen to produce an improved subjective viewing impression by "de-pixelating" the image.

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# INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 92/00396

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>6</sup> According to International Patent Classification (IPC) or to both National Classification and IPC IPC5: H 04 N 5/64, 15/00, 13/00														
<b>II. FIELDS SEARCHED</b> <div style="text-align: center;">Minimum Documentation Searched<sup>7</sup></div> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 20%;">Classification System</th> <th style="width: 80%;">Classification Symbols</th> </tr> <tr> <td style="height: 40px; vertical-align: top;">IPC5</td> <td style="vertical-align: top;">H 04 N</td> </tr> </table>			Classification System	Classification Symbols	IPC5	H 04 N								
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Documentation Searched other than Minimum Documentation to the extent that such Documents are included in Fields Searched <sup>8</sup> <div style="height: 40px;"></div>														
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Category<sup>10</sup></th> <th style="width: 60%;">Citation of Document<sup>11</sup> with indication, where appropriate, of the relevant passages<sup>12</sup></th> <th style="width: 30%;">Relevant to Claim No.<sup>13</sup></th> </tr> </thead> <tbody> <tr> <td style="vertical-align: top;">X  Y   --</td> <td style="vertical-align: top;">WO, A1, 8401680 (SAKARIASSEN ARNVID) 26 April 1984, see page 1, line 1 - page 3, line 18; figure 2</td> <td style="vertical-align: top;">1-4,7-8  5,6</td> </tr> <tr> <td style="vertical-align: top;">X  Y   --</td> <td style="vertical-align: top;">US, A, 4636866 (NOBORU HATTORI) 13 January 1987, see column 2, line 30 - column 5, line 40; figures 1-3,5,7</td> <td style="vertical-align: top;">1-4,7-8  5,6</td> </tr> <tr> <td style="vertical-align: top;">X  Y   --</td> <td style="vertical-align: top;">US, A, 4982278 (THOMAS R. DAHL) 1 January 1991, see column 2, line 10 - column 3, line 5</td> <td style="vertical-align: top;">1-4,7-8  5,6</td> </tr> </tbody> </table>			Category <sup>10</sup>	Citation of Document <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>	X  Y   --	WO, A1, 8401680 (SAKARIASSEN ARNVID) 26 April 1984, see page 1, line 1 - page 3, line 18; figure 2	1-4,7-8  5,6	X  Y   --	US, A, 4636866 (NOBORU HATTORI) 13 January 1987, see column 2, line 30 - column 5, line 40; figures 1-3,5,7	1-4,7-8  5,6	X  Y   --	US, A, 4982278 (THOMAS R. DAHL) 1 January 1991, see column 2, line 10 - column 3, line 5	1-4,7-8  5,6
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<div style="display: flex; justify-content: space-between;"> <div style="width: 48%;"> <p><sup>10</sup> Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 48%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principles or theory underlying the invention</p> <p>"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&amp;" document member of the same patent family</p> </div> </div>														
<b>IV. CERTIFICATION</b> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 5px;">           Date of the Actual Completion of the International Search   <div style="text-align: center;">7th August 1992</div> </td> <td style="width: 50%; padding: 5px;">           Date of Mailing of this International Search Report   <div style="text-align: center;">15 SEP 1992</div> </td> </tr> <tr> <td style="width: 50%; padding: 5px;">           International Searching Authority   <div style="text-align: center;">EUROPEAN PATENT OFFICE</div> </td> <td style="width: 50%; padding: 5px;">           Signature of Authorized Officer   <div style="text-align: center;">B. LJUNGDAHL</div> </td> </tr> </table>			Date of the Actual Completion of the International Search  <div style="text-align: center;">7th August 1992</div>	Date of Mailing of this International Search Report  <div style="text-align: center;">15 SEP 1992</div>	International Searching Authority  <div style="text-align: center;">EUROPEAN PATENT OFFICE</div>	Signature of Authorized Officer  <div style="text-align: center;">B. LJUNGDAHL</div>								
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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
X	US, A, 4933755 (THOMAS R. DAHL ET AL) 12 June 1990, see column 1, line 59 - column 2, line 23	1-4,7,8
Y	--	5,6
X	FR, A, 2647290 (PATRICK FOULGOC) 23 November 1990, see page 9, line 10 - line 30	1-4,7-8
Y	--	5,6
X	US, A, 4395731 (ARNOLD SCHOOLMAN) 26 July 1983, see figures 5,7,8	1-4,7,8
Y	--	5,6
X	US, A, 4706117 (ARNOLD SCHOOLMAN) 10 November 1987, see figures 6-8,10	1-4,7,8
Y	--	5-6
X	Patent Abstracts of Japan, Vol 13, No 126, E734, abstract of JP 63-294186, publ 1988-11-30 KAWASAKI HEAVY IND LTD	1-4,7,8
X	US, A, 2955156 (M.L.HEILIG) 4 October 1960, see figure 1	1,2,4,7, 8
Y	--	5,6
P,X	US, A, 5034809 (HIDEAKI KATOH) 23 July 1991, see column 7, line 5 - line 23	1-8
P,X	EP, A1, 0438362 (SONY CORPORATION) 24 July 1991, see figures 5-8	1-4,7,8
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## III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
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